House Price Distributions of Taiwan: A Preliminary Study

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The house price distributions of Taiwan are analyzed. The tail of the cumulative distribution function (CDF) follows an approximate power law with an exponent equals to -2.4 while the distribution of the house price per unit area displays a lognormal distribution. Implications of the results are also discussed.

Many complex systems exhibit heavy-tailed distributions in observables that characterize the systems. Among them are natural hazards such as earthquakes, landslides, wildfires [1] or the ranking of words used in literature [2]. In a recent work [3], it was realized that the tail of the house price distribution in the Greater Tokyo Area differs significantly from a lognormal distribution as would have been assumed by many people, and in fact display a power law behavior. One would want to ask if this kind of behavior is universal or just a special case related to the Greater Tokyo Area. Indeed, a better understanding of the evolution of real estate prices such as the house price distribution might help the government to have a better control over the abnormal price fluctuations and thus to avoid economic downturns before they really happen. In this preliminary study, we report the distribution of house price in Taiwan in 2010. In order for Taiwanese citizens to gather better information about the house price in various areas in Taiwan, its government started in 2010 to regularly release the data of the price of house that are recently sold. The first set of released data is the price of house sold in the first quarter of 2010 in Taiwan [4]. In this set of data, there are a total of 7,374 units (including houses, apartments, factories, etc) sold during this period. Of these seven thousand plus units, only 6,696 of them are for residential use so we will only include these six thousand plus units in the following analysis.

Figure 1 is the log-log plot of the cumulative distribution function (CDF) of the residential house price in Taiwan in the first quarter of 2010. This CDF includes both the residential house price in urban as well as suburban and rural areas. The x-axis is the total price for the house sold and the unit here is NTD (New Taiwanese Dollar, 1 USD $\approx$ 32 NTD) while the y-axis shows the number of cases sold. One can see that the tail of the cumulative

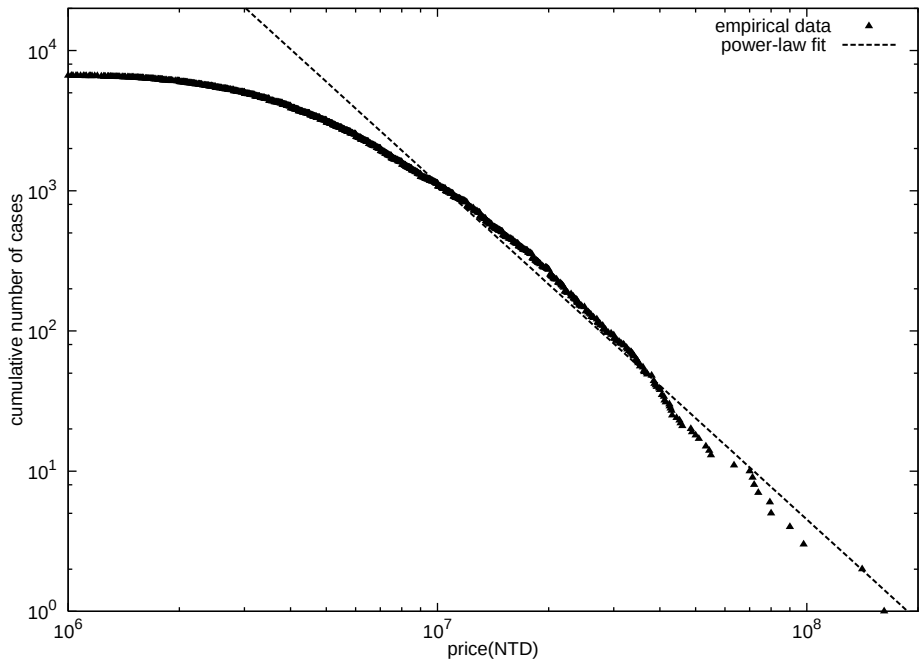

FIG. 1: The cumulative distribution function (CDF) of the residential house price in Taiwan in the first quarter of 2010. The tail exhibits an approximate power law behavior with an exponent of -2.4.

distribution function significantly differs from an exponential or lognormal distribution. In fact, the tail can be approximated by a power law distribution with an exponent of about -2.4. This result is very similar to that of the CDF obtained in [3].

Figure 2 is the house price per unit area in Taiwan in the same period. The data points in solid triangles show the distribution function for the houses sold throughout Taiwan during this period. The x-axis is the price per unit area (NTD per meter squared) and the y-axis shows the number of cases sold. At first glance, the distribution seems somewhat strange since there is a bump on the right hand side of the peak of the distribution.

Very recently, the Taiwanese government has announced a new restriction on home mortgages in Taiwan. For the designated Greater Taipei Area, the same person gets much stricter restrictions on home mortgage for the second house owned under his/her name. This is because the house price in certain districts in the Greater Taipei Area has almost doubled in the last two years. To have a better understanding of the distribution in Figure 2, we therefore divide the houses sold into two groups, the designated Greater Taipei Area identified by the Taiwanese government and the rest of Taiwan. The PDF of the house price per unit

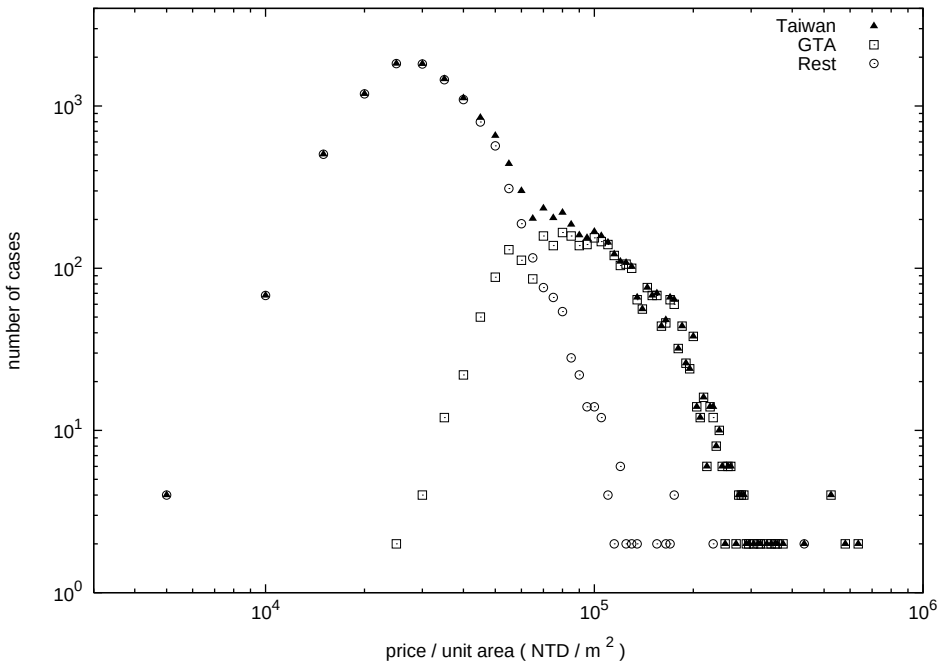

FIG. 2: The house price per unit area (NTD/m^2) in Taiwan in 2010. The data points in solid triangles are for the whole Taiwan area. The data points in squares and circles are for the Greater Taipei Area (GTA) and for the rest of Taiwan respectively.

area of these two groups are also included in Figure 2, with the squares for the designated Greater Taipei Area and the circles for the rest of Taiwan. It is surprising to find out that they both follow lognormal distributions though the positions of the peaks are different. In fact, the two lognormal distributions can be put into a single lognormal distribution if one makes a shift of the peaks of the two distributions. To do so, we multiply the house price of each house sold in Taiwan (other than in the designated Greater Taipei Area) by the same constant (ratio), in this case, about 3.3 which effectively means to translate the lognormal distribution to the right. One can now see that the two lognormal distributions collapse into a single lognormal($\frac{1}{x\sigma\sqrt{2\pi}}\exp(\frac{-(ln(x)-\mu)^2}{2\sigma^2})$, with $\mu = 11.5$ and $\sigma = 0.4$), as shown in Figure 3. Notice that the y-axis here is normalized to represent the probability density function (PDF) of the distribution.

Incidentally, the released data from the government [5] indicate that the average income of a family in the Greater Taipei Area in 2009 was about 1.5 times that of the rest of Taiwan. This means that houses in the Greater Taipei Area are indeed overpriced by a factor of about $3.3/1.5 = 2.2$! A policy to correct this huge difference between the Greater Taipei Area and

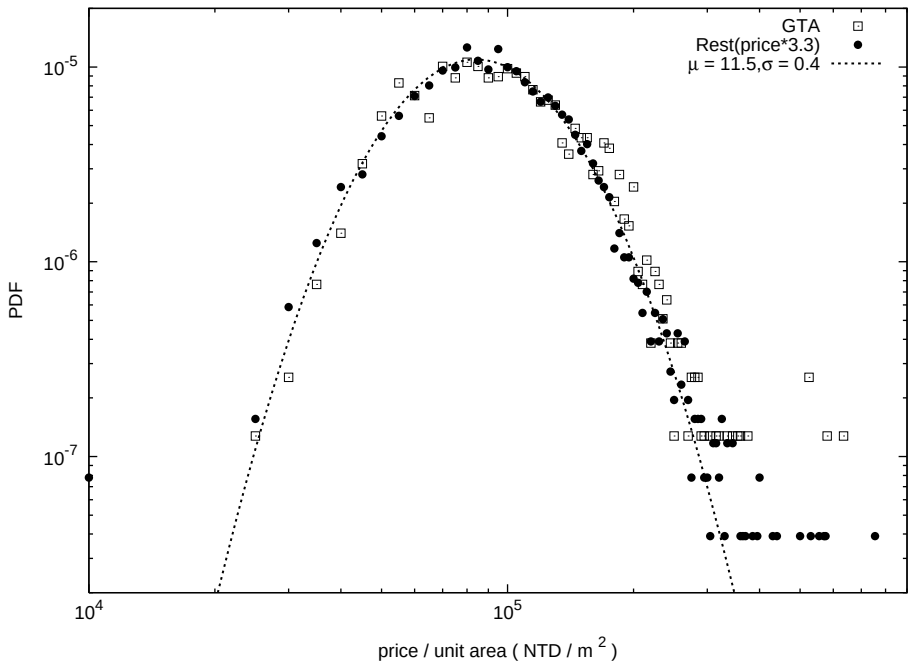

FIG. 3: Rescaled plot of Figure 2. The lognormal distribution of the house price/unit area for houses sold in the first quarter of the rest of Taiwan area is rescaled by multiplying by a factor of 3.3. The two lognormal distributions in Figure 2 now collapse into a single lognormal distribution.

the rest of Taiwan by the government is therefore urgent.

Summary–In this preliminary study of the house price distributions in Taiwan, we found that the tail of the cumulative distribution function (CDF) of the residential house price in Taiwan can be approximated by a power law distribution with an exponent of about -2.4. This is similar to the result obtained in a recent work [3] on the house price in the Greater Tokyo Area. On the other hand, the average house price per unit area in different regions of Taiwan follow lognormal distributions. We have divided the houses sold into two groups–the designated Greater Taipei Area and the rest of Taiwan. Adjusted by a ratio of 3.3, the two lognormal distributions indeed collapse into a single lognormal distribution. From this, we conclude that the houses sold in the Greater Taipei Area are overpriced by a factor of 2.2. This will be indicated by the difference in the Misery Index between urban and suburban areas and will thus be a useful reference for policymakers.

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